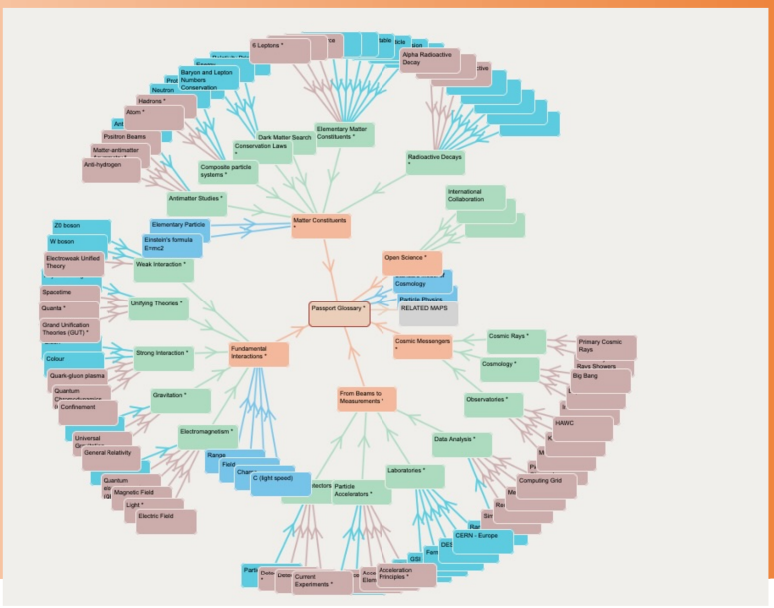
The Infinite Glossary: Cosmic Messengers

All the "Infinite Glossary" items are somehow linked. However, some links are stronger and more directs than others... Here are those related to Cosmic Rays, Cosmology and Observatories.

Two observatories are currently members of IPPOG, and Cosmic Rays are central topics for outreach activities. This section is therefore meant to grow in future.



Translated from 'Glossaire', **Passeport pour les deux infinis,** *IN2P3/Dunod, https://pass2i.ijclab.in2p3.fr/ (French); updated with ICHEP2024 conference (https://ichep2024.org) for IPPOG*

Cosmic Messengers	Cosmological events involve complex interactions between a variety of astrophysical processes, each of which may independently emit signals of a characteristic "messenger" type: electromagnetic radiation (including visible light), gravitational waves, neutrinos, and cosmic rays.
Cosmic Rays	Cosmic rays are fast-moving particles from space that constantly bombard the earth from all directions. Most of the particles are single protons and electrons but few are much heavier nuclei, ranging up to lead. Cosmic ray particles travel at nearly the speed of light, and some are the most energetic particles ever observed in nature. The highest-energy cosmic rays have a hundred million times more energy than the particles produced in the world's most powerful particle accelerator.
Muon Tomography	An imagery technique used to reconstruct the characteristics of an object in 3 dimensions by accumulating uni- or bidimensional information on the penetration of radiation or particle beam. X-rays are commonly used in medicine, as well as positrons. Muons from cosmic rays are also used for bigger objects such as pyramids or volcanoes.
Primary cosmic ray	Primary Cosmic Rays are charged particles that have been accelerated to enormous energies by astrophysical sources somewhere in our universe. They must be stable in order to survive the long trips through interstellar (or intergalactic) space. If they are charged, and therefore swerved by magnetic fields, it is extremely difficult to locate their source. Experiments on satellites can perform direct studies on their composition, and look for the presence of antimatter.
Secondary cosmic ray showers	When cosmic rays enter the Earth's atmosphere, they collide with atoms and molecules, mainly oxygen and nitrogen. The interaction produces a cascade of lighter particles, a so-called air shower secondary radiation that rains down, including x-rays, protons, alpha particles, pions, muons, electrons, neutrinos, and neutrons. All of the secondary particles continue onward on paths within about one degree of the primary particle's original path, and are detected by observatories.
Cosmology	The science which studies the general characteristics of the Universe, such as its broad structures, its matter and its energy content, or its evolution from the Big Bang to the present time. Cosmology is a branch of astronomy that stands at the crossroads between the infinitely small and the infinitely large.

Big Bang	In our present understanding of the Universe's history, the moment when it all started. From then on, the Universe evolved from a hot, extremely dense state to its current cold, dilated state. The whole process has taken about 14 billion years. We are not able to describe the Big Bang event itself nor what existed before.
Expansion	In 1929, Edwin Hubble discovered the universe is continuously growing in scale over time. This implies that the distances between galaxies and other cosmic structures are increasing as time progresses. Observations suggest that rate of expansion is increasing over time, phenomenon attributed to a mysterious form or energy, called dark energy.
Inflation	A theory proposing a period of extremely rapid exponential expansion of the universe in its very early stages, right after the Big Bang. It is able to predict the universe uniformity in all directions and its tiny temperature fluctuations. Inflation has strong observational support, though there are still many details to uncover and understand.
Observatories	An observatory is a location used for observing terrestrial, marine, or celestial events. Astronomical observatories are mainly divided into four categories: space-based, airborne, ground-based, and underground-based. Two of them are currently IPPOG members, AUGER and HAWC.
HAWC	The High Altitude Water Cherenkov Observatory is located in the Mexican state of Puebla at an altitude of 4100 meters. HAWC detects showers produced by high energy cosmic rays which hit the Earth's atmosphere. It monitors the northern sky and makes coincident observations with other observatories such as VERITAS, HESS, MAGIC, IceCube, CTA and the Fermi Gamma-ray Space Telescope, to obtain multi-wavelength and multi-messenger observations on cosmic phenomena.
Kamiokande	A neutrino underground observatory located near Mozumi, Japan. Kamiokande and its successor, Super-Kamiokande and SuperKGd, were designed to detect high-energy, solar and atmospheric neutrinos and keep watch for supernovae in the Milky Way Galaxy by detecting the Cherenkov light emitted during reactions between neutrinos and the water contained in a large volume. Gadolinium was introduced into the water tank in 2020 in order to distinguish neutrinos from antineutrinos that arise from supernova explosions.
Pierre Auger observatory	The Pierre Auger Observatory is an international cosmic ray observatory in Argentina designed to detect ultra-high-energy cosmic rays. In Earth's atmosphere such particles interact with air nuclei and produce various other particles. These effect particles (called an "air shower") are detected and measured in a detection area of 3,000 km2, allowing the reconstruction of the primary ray direction and energy.